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The Heavy Division Engineer Regiment —
A Key To Tactical Freedom Of Action

A Monograph
by

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ABSTRACT

THE HEAVY DIVISION ENGINEER REGIMENT--A KEY TO TACTICAL FREEDOM OF ACTION by MAJ Marc R. Hildenbrand, USA, 54 pages.

This study answers the following question related to the "Engineer Restructure Initiative": Is the proposed division engineer (DIVENG) regiment capable of creating the conditions necessary to maintain the heavy division's tactical freedom of action on the AirLand battlefield?

In answering the foregoing question, the monograph first examines applicable theory to establish the relationship between mobility, engineer support in offensive operations, and tactical freedom of action. Second, two historical examples--the 1944 American Normandy campaign and the 1944 German Ardennes counteroffensive--illustrate the role engineers play in maintaining tactical freedom of action. Next, the DIVENG regiment's organization, command and control, tactical doctrine, and equipment are analyzed. Finally, appropriate conclusions and recommendations are made.

Overall, the monograph concludes that the DIVENG regiment helps maintain the heavy division's tactical freedom of action. From the study conducted, three major additional conclusions and recommendations emerge. First, the Army must develop an in-stride obstacle breaching capability. Second, the Army must modernize engineer equipment. Finally, the obsolescence of most engineer equipment highlights the need to harmonize all of the Battlefield Operating Systems' components. Until such harmonization occurs, the full potential of AirLand Battle doctrine will never be reached.

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INTRODUCTION

Since World War II, most Army combat systems have experienced order of magnitude improvements in speed. For example, both the Abrams Tank and the Bradley Fighting Vehicle can travel faster than 40 miles per hour.¹ Additionally, AirLand Battle doctrine is offensively oriented, and the defense is only a temporary expedient prior to resuming offensive operations.²

In harnessing combat system speed in offensive warfare, the concepts of mobility and tactical freedom of action must be understood. Unfortunately, both concepts are frequently misunderstood. For example, mobility is often viewed strictly as a function of how fast combat systems can move.³ As technologically splendid as the Abrams and Bradley are, vehicular speed alone does not ensure a combat formation's mobility or tactical freedom of action. Instead, many factors determine the degree of mobility and tactical freedom of action a combat unit possesses. Further, engineer operations may well be the key to achieving tactical freedom of action on the AirLand battlefield.

Today, the Army is completely reorganizing the way engineers support the combined arms team. The reorganization's specifics, known as the "Engineer Restructure Initiative", are contained in the February

1991 coordinating draft of *Field Manual 5-71-100, Regimental Engineer Combat Operations*. This study answers one question related to the "Engineer Restructure Initiative", to wit: Is the proposed division engineer (DIVENG) regiment capable of creating the conditions necessary to maintain the heavy division's tactical freedom of action on the AirLand battlefield? If the heavy division cannot maintain tactical freedom of action, a major AirLand Battle doctrinal strength will be eroded. Therefore, answering the foregoing research question is important.

In answering the research question, the fundamental tenets of AirLand Battle doctrine-- *INITIATIVE, AGILITY, SYNCHRONIZATION*, and *DEPTH*--serve as analytic criteria. The rationale for using AirLand Battle tenets as analytic criteria is developed in the monograph's applicable theory section. Each tenet is defined as follows:

INITIATIVE - setting or changing the terms of battle by action.

AGILITY - acting faster than the enemy.

SYNCHRONIZATION - the arrangement of battlefield activities in time, space, and purpose to produce maximum relative combat power at the decisive point.

DEPTH - the extension of operations in space, time, and resources.†

Field Manual 100-5, Operations discusses each tenet in greater detail.

Following the introduction, the monograph is divided into four main parts: applicable theory, historical evidence, the heavy division engineer regiment, and a combined conclusions and recommendations section. Overall, the monograph concludes the DIVENG regiment is capable of creating the conditions necessary for the heavy division to maintain tactical freedom of action. Further, the DIVENG regiment represents a significantly improved use of currently available engineer resources. However, inadequate engineer equipment--particularly the lack of a true in-stride minefield breaching capability--inhibits AirLand Battle doctrine from reaching its full potential.

APPLICABLE THEORY

As highlighted in the preceding section, current AirLand Battle doctrine is offensively oriented.⁵ To appreciate the engineer role in offensive warfare, two concepts must be understood: tactical freedom of action and mobility. This section briefly examines both concepts and illustrates the relationship between tactical freedom of action, mobility, and engineer support in offensive operations.

Tactical freedom of action is the first concept requiring examination. Unfortunately, what constitutes tactical freedom of action is often misunderstood. Part of the misunderstanding regarding tactical freedom of action is attributable to the way *Field Manual 100-5, Operations*, uses the term. Although *Field Manual 100-5* refers to freedom of action, the meaning of tactical freedom of action is never defined. Instead, *Operations* frequently implies tactical freedom of action results from travelling by unexpected routes and striking where the enemy "has taken no precautions."⁶ Such a view is too simplistic; combat units will rarely discover places where the enemy is completely susceptible to attack. More commonly maneuver units will be forced to fight for tactical freedom of action.⁷ If the previous statement is true, what is tactical freedom of action? In this study, tactical

freedom of action is defined as: the ability of a combat formation to execute--despite enemy actions to the contrary--a selected course of action. When a force completely executes a selected course of action, total freedom of action exists. When a force partially executes a selected course of action, some degree of freedom of action exists. When a force cannot execute a selected course of action, no freedom of action exists.

A relationship exists between tactical freedom of action and the tenets of AirLand Battle. Evidence for the foregoing relationship is derived from the following statement in *Field Manual 100-5*:

they [AirLand Battle tenets] are the basis for the development of all current US Army doctrine, tactics, and techniques ...All combat, combat support, and combat service support doctrine are derived directly from, and must support, these fundamental tenets.⁸

The previous quote indicates AirLand Battle tenets are the basis for all US Army doctrine; the concept of freedom of action is part of current Army doctrine. Therefore, tactical freedom of action must be a function of the tenets of AirLand Battle. The previous idea can be expressed as:

Tactical Freedom of Action is a $f(I, A, S, D)$ where I, A, S, D represent *INITIATIVE, AGILITY, SYNCHRONIZATION*, and *DEPTH* respectively. Logically

then, increasing *INITIATIVE*, *AGILITY*, *SYNCHRONIZATION*, and *DEPTH* enhances tactical freedom of action--the ability of a combat formation to execute a selected course of action. Further, a combat unit incapable of executing operations in accordance with the tenets of AirLand Battle doctrine is incapable of achieving tactical freedom of action. The preceding ideas set the stage for examining the second key concept related to engineer support in offensive operations--mobility.

Mobility is frequently viewed in terms of how fast combat systems can move.⁹ Such a view is incomplete. Instead, a unit's mobility is a complex function determined by many variables including equipment capabilities, maintenance proficiency, weather conditions, and unit movement skills.¹⁰ In this light, a combat formation's mobility potential is the aggregate of all factors enabling a unit to move. In modern warfare, existing and reinforcing obstacles are the dominant factors influencing a unit's ability to move.¹¹

Within the Army, engineers have the primary responsibility for overcoming both existing and reinforcing obstacles.¹² Existing obstacles dominate large portions of the earth's surface, and such obstacles include rivers, urban areas, swamps, woodlands, and mountains. Germany's terrain illustrates the potential impact of existing obstacles.

In Germany, attacking divisions will encounter an average of five gaps greater than 20 meters, five gaps between 6 and 20 meters, and fifteen gaps between 2 and 6 meters for every twenty kilometers moved.¹³ Also in Germany, major water obstacles occur every three kilometers in east-west movements and every five kilometers during north-south movements.¹⁴ Besides existing obstacles, reinforcing obstacles--such as mines, intentional urban rubble, and blown bridges--will be strewn across the battlefield. An especially significant challenge for maneuver commanders are smaller, more lethal, scatterable mines. Such mines can be quickly emplaced by soldiers, artillery, and aircraft.¹⁵ For example, in only minutes a single Soviet multiple rocket launcher battery can produce an effective four square kilometer scatterable minefield.¹⁶ Currently, more than twenty-two countries possess scatterable mines,¹⁷ and one study concludes attacking brigades may be forced to breach three minefields every 24 hours.¹⁸

The impact of existing and reinforcing obstacles on a unit's mobility is threefold. First, obstacles tend to favor the defender.¹⁹ Second, unlike the essentially instantaneous effect of direct and indirect fires, an obstacle's influence persists until the obstacle is either breached or by-passed.²⁰ Finally, without extensive engineer support, the combined arms

team cannot advantageously exploit mobility potential--no matter how fast combat systems can move. For example, an attacking division encountering a major river without floating bridge assets has no forward mobility. Therefore, engineer support in offensive operations--breaching obstacles, crossing dry and wet gaps, and constructing and maintaining routes--is a prerequisite to exploiting mobility potential.

When engineer operations improve a combat formation's ability to exploit mobility potential, the tenets of AirLand Battle are enhanced. Again, the case of a heavy division crossing a river illustrates the previous idea. By enabling maneuver forces to cross a river, engineers help expand the battlefield's *DEPTH*. When *DEPTH* is increased, the heavy division's ability to achieve *INITIATIVE*--set or change the terms of battle by action, *AGILITY*--act faster than the enemy, and *SYNCHRONIZATION*--maximize relative combat power at the decisive point--is also increased. With adequate engineer support, the ability of the combined arms team to conduct operations characterized by the tenets of AirLand Battle is increased. Without adequate engineer support, the probability of executing operations in accordance with AirLand Battle tenets is always decreased and sometimes totally eliminated. Consequently, engineer operations are vital for a

combat formation to exploit mobility potential to advantage.

The overall relationship between mobility, engineer support in offensive operations, and tactical freedom of action can now be summarized. Without engineers the battlefield's existing and reinforcing obstacles make the successful exploitation of mobility potential difficult at best and impossible at worst. In contrast, engineer reduction of obstacles liberates a combat unit's mobility potential. Once mobility potential is liberated, friendly forces are better able to achieve *INITIATIVE, AGILITY, SYNCHRONIZATION, DEPTH*, and eventual positional advantage over the enemy.²¹ Once positional advantage is attained, firepower can be used to destroy the enemy. Further, since tactical freedom of action is a function of AirLand Battle tenets, engineer operations enhance--but because of possible enemy counteractions do not guarantee--overall tactical freedom of action. Appendix 1-A illustrates the relationships between mobility, engineer support in offensive operations, and tactical freedom of action.

From the theoretical analysis conducted, three primary interim conclusions emerge. First, without adequate engineer support, a combat formation is unlikely to advantageously exploit mobility potential, and the possibility of achieving *INITIATIVE, AGILITY, SYNCHRONIZATION*, and *DEPTH* is remote. Second, tactical

freedom of action is a function of the tenets of AirLand Battle. Therefore, engineer enhancement of the tenets of AirLand Battle enhances overall tactical freedom of action. Finally, there is an inter-relationship between mobility, engineer operations, tactical freedom of action, and AirLand Battle tenets. Therefore, *INITIATIVE*, *AGILITY*, *SYNCHRONIZATION*, and *DEPTH* are appropriate analytic criteria for this study.

At this point, a theoretical appreciation of the relationship between mobility, engineer support in offensive operations, and tactical freedom of action has been established. In the following section, two historical examples further illustrate the foregoing relationship.

HISTORICAL EXAMPLES

Military history provides an invaluable database for better understanding war. In this monograph, two World War II Western European operations illustrate the role engineers play in creating the conditions necessary for maintaining freedom of action: the 1944 American Normandy Campaign preceding Operation COBRA and the 1944 German Ardennes counteroffensive.

THE 1944 AMERICAN NORMANDY CAMPAIGN

In the early morning hours of June 6, 1944, the Allies launched the greatest invasion in history. The Normandy invasion represented the first step in the final trek towards destroying Nazi Germany, and restoring peace in Western Europe. The American portion of the Normandy invasion force was the most mobile army of its day. All elements of a typical American division--except infantry units--were completely motorized. By attaching only six additional truck companies, infantry units became fully motorized as well.²² In contrast, the German infantry divisions defending Normandy depended on marching and horse transport for tactical movements.²³

By early July 1944, the Normandy lodgement contained almost a million Allied soldiers, half a million tons of supplies and more than 177,000

vehicles.²⁴ However, this massive combat power was constricted within an area approximately sixty miles long by ten miles deep. In places the beachhead extended less than five miles inland.²⁵

The shallow Allied beachhead was primarily due to Normandy's terrain. The Norman *bocage*--small fields surrounded by massive hedgerows, about twelve feet high and eight feet thick--was reinforced by German obstacles, roadblocks, minefields, antitank guns, and fortifications.²⁶ These obstacles forced American soldiers to fight forward hedgerow by hedgerow. Each time a hole was smashed through the *bocage* the German defenders retreated and placed additional obstacles in the attacker's path.²⁷ Under these conditions clearing the hedgerows became a tense, slow affair performed at close range.²⁸

Throughout June and July 1944, American engineers, in concert with their armor and infantry brethren, waged "the grueling positional warfare of the battle of the hedgerows."²⁹ To protect dozer operators while breaching hedgerows and other obstacles, bulldozers were equipped with makeshift "armored" cabs.³⁰ Using armored dozers and other sapper tools, engineers breached obstacles obstructing the American advance. Infantry and tanks then poured through the breach and attacked the German defenders. This "ongoing around-

the-clock mission" continuously expanded the Allied beachhead.³¹

As operations continued General Omar Bradley devised a plan to pierce the German defensive cordon. Bradley's intent was to initiate an offensive campaign capitalizing on the US Army's mobility potential. The plan, codenamed Operation COBRA, envisioned using airpower to blow a hole one mile deep by five miles wide in the German defenses. Before the enemy could react, American mechanized and motorized columns would surge through the resulting gap and shatter the Normandy stalemate.³² By July 10, Bradley chose the village of St Lo as COBRA's starting point.³³

From July 10th onwards engineer units supported the American drive towards St Lo. Subsequent ground gains were not without cost. In the forty-eight days between June 6 and July 24 the Allies suffered 122,000 casualties.³⁴ Nonetheless, despite the German's possession of an extensive natural obstacle system--the *bocage*--reinforced with countless man-made obstacles, American progress toward St Lo could not be stopped. By July 24, the conditions required to launch COBRA were set, and the next day COBRA was launched. Within weeks the course of the war in Western Europe was completely changed, and by early September the Allies were nearing Germany itself (Appendix 2-A).³⁵

In Normandy American engineers helped the combined arms team maintain the *INITIATIVE*. Despite a strong and determined German defense, sappers overcame obstacles, and created the conditions necessary to maintain tactical freedom of action. During the push towards St Lo engineers permitted Bradley's forces to set or change the terms of battle by action, and the Americans constantly took the fight to the Nazis.

American engineers also helped maintain *AGILITY*. Although the American advance was not a "bloodless" affair, the Germans defending Normandy were seldom able to act faster than the Allies. The continuous Allied advance along a broad front--frequently spearheaded by engineers--"prevented the enemy from building strong mobile reserves and concentrating them in offensive action against any one point."³⁶

SYNCHRONIZATION characterized American operations preceding COBRA. Substantial numbers of engineers were positioned well forward--often in front of maneuver elements. Once sappers created a gap in the *bocage* or other obstacles concentrations of armor and infantry soldiers rushed through the breach and attacked the German defenders.

Finally, engineer operations in Normandy increased the battlefield's *DEPTH*. From D-day forward, engineer operations assisted the expansion of the Normandy

lodgement. In so doing, the conditions necessary for launching Operation COBRA were created.

Throughout the Normandy campaign engineers increased the US Army's *AGILITY, INITIATIVE, DEPTH*, and *SYNCHRONIZATION*. Consequently, American tactical freedom of action was enhanced and maintained, and Bradley's forces were able to set the conditions necessary for launching Operation COBRA.

THE 1944 GERMAN ARDENNES COUNTEROFFENSIVE

In the fall of 1944, Hitler devised an ambitious counteroffensive plan--codenamed Operation *WACHT AM RHEIN* (Watch on the Rhine) for deception purposes--to turn the Western European war in the Nazi's favor. The *WACHT AM RHEIN* plan was divided into three main phases. The first phase required a rapid penetration of Allied defensive positions in the Ardennes.³⁷ The next phase called for the establishment of bridgeheads across the Meuse River between Liege and Namur. In the last phase the Meuse bridgeheads would serve as springboards for seizing the strategic port of Antwerp (Appendix 3-A).³⁸ The *Sixth Panzer Army* was selected as the counteroffensive's main effort (Appendix 3-A).³⁹ Colonel Peiper's *Kampfgruppe Peiper*--with over one hundred and forty tanks--would spearhead the *Sixth Panzer Army* drive to the Meuse River.⁴⁰

Kampfgruppe Peiper's soldiers were not martial novices. Peiper had served as a battalion commander in Russia, and most of his troops were also Eastern Front veterans.⁴¹ Furthermore, the *1st SS Panzer Division* to which *Kampfgruppe Peiper* belonged was the oldest unit of Hitler's praetorian guard, and the *1st Panzer's* soldiers were dedicated Nazi's.⁴² As such, *Kampfgruppe Peiper* could be expected to complete its mission of seizing crossing sites over the Meuse River near Huy.⁴³ The timetable for Peiper's mission was ambitious: one day to achieve penetration and breakout, one day to cross the Ardennes, the Meuse River to be reached by the third day, and crossing sites to be secured by the fourth day (Appendix 3-B).⁴⁴ Although *Kampfgruppe Peiper's* task organization included engineers, Peiper positioned his sappers to the rear of his column.⁴⁵ Peiper's placement of engineers proved to be a critical mistake.

In the early morning hours of December 16, 1944, a jolting artillery barrage signaled the start of the *WACHT AM RHEIN* counteroffensive. At 1930 hours on the same day, *Kampfgruppe Peiper* was committed to battle. Peiper's planned route lay along the axis LOSHEIM-LIGNEUVILLE-TROIS PONTS-WERBOMONT-HUY (Appendix 3-C).⁴⁶ By 1300 hours on the 17th, Peiper's column reached Ligneuville.⁴⁷ Peiper's next objective was Stavelot. Early in the evening of December 17, three German tanks

rushed the Stavelot bridge. When the lead German tank was destroyed, Peiper's vanguard fell back and assumed defensive positions.⁴⁸ At this time, *Kampfgruppe Peiper* was only forty-two miles from the Meuse River.⁴⁹

The following morning Peiper's soldiers began fighting their way into Stavelot. Before fully securing Stavelot, Peiper dispatched tanks at top speed towards Trois Ponts. As Peiper states:

If we had captured the bridge[s] at Trois Ponts intact [emphasis added]..., it would have been a simple matter to drive through to the Meuse River early that day [December 18].⁵⁰

Shortly before noon, twenty *Kampfgruppe Peiper* tanks approached the outskirts of Trois Ponts. However, Peiper's soldiers discovered all three of Trois Ponts' bridges destroyed (Appendix 3-C).⁵¹ Lacking any engineer assets, Peiper was forced to divert *Kampfgruppe Peiper* north towards La Gleize (Appendix 3-C).⁵² At this point in time, Peiper's tactical freedom of action was seriously eroded.

Near La Gleize German reconnaissance elements located an intact bridge spanning the Ambleve River. Only one last potential obstacle--the Neufmolin Bridge over the Lienne Creek--stood between Peiper and an open road to the Meuse (Appendix 3-C).⁵³ At 1645 hours on December 18, Peiper's lead tanks discovered the Neufmolin Bridge destroyed. Additional German attempts

to find an intact bridge over the Lienne Creek proved fruitless.⁵⁴

Lacking the means to cross the Lienne, Peiper had no alternative but to reorient his entire force eastwards. By the evening of December 18, American airplanes located Peiper's entire column, and two American infantry divisions tightened the noose around *Kampfgruppe Peiper's* neck.⁵⁵ In the days before Christmas 1944, Peiper and his men--having completely failed in their mission--abandoned their fuelless vehicles and began walking towards Germany. Less than eight hundred of *Kampfgruppe Peiper's* original seven thousand soldiers safely reached the German lines.⁵⁶

Kampfgruppe Peiper's experience yields some interesting insights. First, throughout *WACHT AM RHEIN*, Peiper's command rarely possessed the *INITIATIVE*. During the battle, American soldiers thwarted Peiper's every move: delaying *Kampfgruppe Peiper* at Stavelot, diverting Peiper's force north at Trois Ponts, and completely blocking Peiper at the Lienne Creek (Appendix 3-D). Without engineers, Peiper was unable to effectively set or change the terms of battle by action.

Peiper's lack of engineers also gave the American defenders the advantage of *AGILITY*. The Americans--despite the complete surprise of the initial Nazi attack--consistently acted faster than *Kampfgruppe*

Peiper. On December 17, *Peiper's* force stood a mere forty-two miles from the Meuse River--the primary initial objective for the entire *WACHT AM RHEIN* counteroffensive. Lacking forward deployed engineers *Kampfgruppe Peiper* was unable to attain *AGILITY*, and *Peiper's* force was eventually destroyed.

Peiper was also unable to achieve *SYNCHRONIZATION*. Even by current standards, *Kampfgruppe Peiper's* 150 tanks represented a potent armored force. However, the failure to place engineers forward made producing maximum relative combat power at the decisive point problematic at best.

Finally, *Peiper's* failure to position engineers forward removed the possibility of achieving *DEPTH*. Simply reinforcing secondary bridges along the Lienne Creek would have allowed *Peiper* to continuing moving westward. Instead, *Peiper's* inability to increase the battlefield's tactical *DEPTH* at the Lienne Creek forced *Kampfgruppe Peiper* to turn east in defeat.

Lacking the benefit of a totally incompetent adversary, *Peiper's* failure to place engineers forward made achieving *AGILITY*, *INITIATIVE*, *DEPTH*, and *SYNCHRONIZATION* essentially impossible. Consequently, *Kampfgruppe Peiper* could not attain the tactical freedom of action vital to *WACHT AM RHEIN's* success. As a result, the main effort for the entire German counteroffensive was ultimately decimated.

Based on the previous analysis, claiming engineers are the most important element in maintaining tactical freedom of action is a gross misuse of history. However, from both a theoretical and historical perspective, engineers appear to be an important element in maintaining tactical freedom of action. In Normandy, American engineers helped Bradley maintain tactical freedom of action. By possessing tactical freedom of action the US Army was able to establish the conditions necessary to launch Operation COBRA and exploit the American advantage in mobility potential. In contrast, Peiper's mistaken placement of engineers precluded *Kampfgruppe Peiper* from achieving the tactical freedom of action vital to *WACHT AM RHEIN's* success. With the preceding ideas in mind, this study next examines the heavy division engineer regiment.

THE HEAVY DIVISION ENGINEER REGIMENT

So far, applicable theory and historical evidence have been examined. Synthesizing the key ideas from the preceding sections yields three primary interim conclusions. First, in offensive operations, achieving *INITIATIVE, AGILITY, SYNCHRONIZATION, and DEPTH* requires engineers. Second, a combat unit's mobility potential is useless unless the tactical freedom of action necessary to advantageously exploit such potential exists. Finally, tactical freedom of action is a function of AirLand Battle tenets. Therefore, engineer enhancement of *INITIATIVE, AGILITY, SYNCHRONIZATION, and DEPTH* increases tactical freedom of action.

The monograph now focuses on the heavy division engineer regiment and sets the stage for answering the monograph's central question: Is the division engineer (DIVENG) regiment capable of creating the conditions necessary to maintain the heavy division's tactical freedom of action on the AirLand battlefield? In this section, the monograph is divided into four main parts. Part one highlights key aspects of AirLand Battle doctrine. The next portion briefly discusses the three major engineer offensive functions. The third part examines the DIVENG regiment's organization, command and control, doctrine, and major offensive equipment.

Finally, the analytic criteria of *INITIATIVE*, *AGILITY*, *SYNCHRONIZATION*, and *DEPTH* are used to develop applicable interim conclusions.

Current US Army warfighting doctrine is clearly offensively oriented.⁵⁷ AirLand Battle tactical offensives are rapid, violent operations which swiftly shift the main effort and promptly exploit success.⁵⁸ Battles and engagements are won by effectively maneuvering combat forces.⁵⁹ Effective tactical maneuver requires the movement of combat forces to gain positional advantage over the enemy.⁶⁰ Having attained positional advantage, firepower can be employed to destroy the enemy's ability and will to fight.⁶¹ Consequently, maneuver and firepower are inseparable and complementary elements. Although either may dominate portions of battles or engagements, successful operations are characterized by the coordinated use of both maneuver and firepower.⁶² Finally, to effectively use maneuver and firepower, a combat unit must possess the tactical freedom of action necessary to advantageously exploit its mobility potential.

In supporting offensive operations, engineer operations focus on three key functions:

1. Breaching existing and reinforcing obstacles
2. Crossing dry and wet gaps
3. Constructing and maintaining routes⁶³

The previous three functions are collectively entitled engineer mobility operations. The overall purpose of

engineer mobility operations is to permit friendly forces to maneuver at will.⁶⁴ As such, engineer mobility operations are never ends in themselves. Instead, engineer mobility operations are used to create the necessary conditions for tactical freedom of action.

In executing engineer mobility operations, the heavy division's organic sapper structure is radically altered. The "Engineer Restructure Initiative" DIVENG regiment is designed with an 80 percent focus on engineer mobility operations, and a 20 percent focus on other engineer missions.⁶⁵ However, can the DIVENG regiment truly create the conditions necessary to maintain the heavy division's tactical freedom of action? In answering the preceding question, four facets of the regiment will be analyzed:

1. Organization
2. Command and Control
3. Tactical Doctrine
4. Equipment

The DIVENG organizational structure provides a full colonel to command all of the heavy division's organic engineers. The DIVENG regimental commander is responsible--usually in a command relationship--for any engineers operating in the division's area of operations. Directly subordinate to the regimental commander are three sapper battalions, and each battalion is commanded by a lieutenant colonel (Appendix 4-A).⁶⁶ The sapper battalions consist of a

headquarters company and three sapper companies (Appendix 4-B). Normally, each sapper battalion is habitually associated with a ground maneuver brigade. As such, the sapper battalion headquarters provides engineer advise to the brigade commander and staff, and task organizes engineers in the brigade area of operations.⁶⁷ Within each battalion, the sapper company is the basic engineer fighting unit. Each sapper company has a headquarters section, two line platoons, and an assault and obstacle platoon (Appendix 4-C). In the offense, the sapper company is designed to conduct engineer mobility operations as part of a maneuver battalion task force.⁶⁸

The DIVENG regiment's organization is sound. By habitually associating a sapper battalion with a ground maneuver brigade, engineers train in peacetime as part of their wartime combined arms team. Additionally, the DIVENG regiment gives the heavy division substantial organic engineers. In short, the DIVENG organizational structure represents a significant improvement in how engineers support the heavy division.

Command and control is the second facet of the DIVENG regiment worth examining. Normally, a sapper battalion will be provided to a maneuver brigade in a command relationship. As such, the brigade commander--based on the mission, enemy, terrain and weather, troops available and time (METT-T)--can task organize

engineers to best accomplish the mission.⁶⁹ Further, by providing a sapper battalion headquarters to each brigade, engineer communications are improved and the need to create ad hoc engineer command and control headquarters is reduced. Experienced engineer leaders are also provided to maneuver commanders--a captain at task force level, a lieutenant colonel at brigade level, and a colonel at division level.⁷⁰ Most importantly, the command and control structure of the DIVENG regiment improves the maneuver commander's ability to act more rapidly than the enemy. A maneuver commander "cannot depend on constant direction, but must fight independently even when he cannot communicate outside his own zone."⁷¹ The DIVENG regiment provides maneuver commanders with significant, forward arrayed engineer assets needed to conduct an independent fight.

Doctrine is the third area of the DIVENG regiment to look at. Current offensive doctrine requires sappers to rapidly reduce existing and reinforcing obstacles impeding friendly tactical freedom of action. Whenever possible, overcoming obstacles should be done in-stride. According to doctrine, deliberate obstacle breaches--characterized by thorough reconnaissance, detailed planning, extensive preparation, and explicit rehearsals--are only conducted if in-stride reductions are impossible or have failed.⁷² The doctrinal

requirement for the DIVENG regiment to conduct in-stride breaches is completely valid. The lethality of today's battlefield makes deliberate obstacle breaching operations a potential recipe for disaster.

Equipment is the final aspect of the DIVENG regiment to be examined. The "Engineer Restructure Initiative" provides the heavy division with significant quantities of engineer equipment for supporting offensive operations. The five major items of offensive engineer equipment are:

- Armored Personnel Carriers
- Combat Engineer Vehicles
- Armored Vehicle Launched Bridges
- Armored Combat Earthmovers
- Mine Clearing Line Charges⁷³

Appendix 4-D compares current heavy division engineer equipment quantities to DIVENG regiment equipment quantities. In all five cases, the "Engineer Restructure Initiative" significantly improves the quantity of the heavy division's organic offensive engineer equipment. However, numbers alone can be deceiving.

Historically, the US Army has struggled to balance the vehicular mobility of combat, combat support and combat service support units.⁷⁴ Today, the same struggle continues. In the DIVENG regiment, the primary sapper vehicle is the armored personnel carrier (APC). However, on a fast moving, fluid, non-linear battlefield, the APC is not a suitable sapper transport

vehicle. Because of the significant speed differential between modern combat systems and the APC, sappers will frequently lag behind maneuver elements. Consequently, leading maneuver forces will be forced to wait for sappers to arrive at a breach site. During the intervening time period, stationary maneuver units are extremely susceptible to enemy destruction. The need for engineers to be as mobile as maneuver elements is understood. However, not until the 21st century will the resources for translating an acknowledged need into reality be available.⁷⁵

The second major item of engineer offensive equipment is the combat engineer vehicle (CEV). Simply stated, the CEV is unsuitable for executing engineer mobility operations. In offensive operations, the CEV: reduces roadblocks and obstacles; fills craters, ditches and short dry gaps; conducts limited construction of combat trails; and clears rubble and debris. However, like the APC, the CEV is too slow to keep pace with modern maneuver units. Further, the CEV's circa 1950s technology is plagued with maintenance problems.⁷⁶ A combat mobility vehicle replacement for the CEV has an expected fielding date of 2004.⁷⁷ Until then, the Army must "live" with the CEV.

Another major item of engineer offensive equipment is the armored vehicle launched bridge (AVLB). In the

DIVENG regiment, the AVLB is the only bridge organic to the heavy division. Three major problems exist with the AVLB. First, attacking divisions may encounter as many as five gaps greater than 20 meters in width for every twenty kilometers moved.⁷⁸ However, the AVLB is incapable of spanning a gap wider than 18.3 meters.⁷⁹ Second, the AVLB cannot safely carry tracked vehicles exceeding military load class 60.⁸⁰ Today, the Abrams Tank significantly exceeds military load class 60. Consequently, the DIVENG regiment's only organic bridge is not load classified to cross a key combat vehicle. Plans exist to replace the AVLB with a heavy assault bridge capable of carrying Military Load Class 70 vehicles across a 24 meter gap. However, the heavy assault bridge program is unfunded.⁸¹ Finally, the AVLB, like the APC and the CEV, is too slow to keep up with maneuver units.⁸²

Unlike the three previous vehicles, the armored combat earthmover (ACE) is an effective sapper vehicle. In offensive operations, the ACE's primary mission is to clear and maintain routes.⁸³ In virtually all combat situations, the ACE can keep pace with modern tanks and infantry fighting vehicles. Also, the armored protection the ACE affords its operator is consistent with fighting on a modern battlefield. During Operation DESERT STORM, the ACE was the only engineer vehicle characterized as a winner.⁸⁴

The final major item of DIVENG regiment offensive equipment is the mine clearing line charge (MICLIC). The MICLIC is inadequate for conducting doctrinally prescribed in-stride minefield breaches. In fact, the MICLIC represents countermine warfare capability which is "essentially the same as at the end of World War II."⁸⁵ The MICLIC is a trailer transported, rocket projected explosive line charge. When a minefield is discovered, the MICLIC is towed forward and fired. Against conventionally fused mines, the MICLIC clears a lane 8 meters wide by 100 meters deep. The process of towing forward and firing MICLICs continues until a sufficiently deep breach is achieved.⁸⁶ From the breaching process just described, two points are apparent. First, against all but the most inept of adversaries, the MICLIC is not survivable. A basic countermobility rule is to cover minefields by fire. Under such conditions the probability of successfully positioning an unarmored trailer is low. Second, the MICLIC is too slow. If friendly commanders are to conduct doctrinally prescribed in-stride breaches, speed is of the essence. However, the MICLIC epitomizes slowness.

As a result, the US Army does not possess an in-stride minefield breaching capability.⁸⁷ This fact is recognized by the General Officer Steering Committee on

Countermine Warfare:

By the 21st century, it is more than feasible that...obstacles to movement could be located, reported, breached, marked, and crossed in-stride and under fire.⁸⁸

For the US Army, deliberate minefield breaching operations will continue as the rule rather than the exception.

One final issue regarding the DIVENG regiment's offensive equipment must be addressed. Under the "Engineer Restructure Initiative", the heavy division has no organic floating bridge assets and no capability to cross a dry gap exceeding 18.3 meters in width. Consequently, the heavy division is totally dependent on corps resources for the preceding capabilities. In war, the need to take advantage of fleeting opportunities occurs frequently. The DIVENG regiment's lack of organic bridging assets--other than the AVLB--may cost the heavy division the loss of potentially decisive opportunities. However, in a superb analysis related to this issue, a former Advanced Military Studies Program student concluded corps control of specialized bridge assets is workable.⁸⁹ With proper command emphasis and proactive planning, the DIVENG regiment's limited bridging equipment should not be an offensive "showstopper."

Applying the monograph's analytic criteria to the DIVENG regiment's organization, command and control,

tactical doctrine, and equipment results in a number of interim conclusions. Foremost, the DIVENG regiment increases the heavy division's capability to execute offensive operations characterized by *INITIATIVE*, *AGILITY*, *SYNCHRONIZATION*, and *DEPTH*. In so doing, overall tactical freedom of action is increased.

The DIVENG regiment enhances the heavy division's ability to achieve *INITIATIVE*. The "Engineer Restructure Initiative" provides a significant level of organic engineer capability within each heavy division. This capability helps maneuver commanders concentrate rapidly, exploit enemy soft spots, act independently within the framework of the higher commander's intent, and swiftly shift the main engineer effort to exploit success.⁹⁰

The "Engineer Restructure Initiative" also increases the heavy division's *AGILITY*. With three organic sapper battalions, maneuver commanders are better able to act faster than the enemy. However, two factors hinder the heavy division's ability to achieve the full degree of *AGILITY* envisioned by *Field Manual 100-5*. First, with the exception of the ACE, the DIVENG regiment lacks modern engineer equipment. At present, the regiment's major items of offensive equipment are, for the most part, representative of circa 1950s technology. Such obsolete equipment is poorly suited to support, in essence, 21st century

combat systems like the Abrams Tank and Bradley Fighting Vehicle. Second, although doctrine calls for in-stride obstacle reductions, the heavy division will experience great difficulty in conducting anything other than deliberate breaching operations. At the National Training Center, 72% of all combined arms breaching operations were rated below standard or lower.⁹¹ Against a competent adversary, the lack of an in-stride breaching capability could be catastrophic.

The DIVENG regiment enhances battlefield *SYNCHRONIZATION*. Effective *SYNCHRONIZATION* only occurs after combined arms formations train, rehearse, and execute together. The habitual association of an entire sapper battalion with a ground maneuver brigade increases the heavy division's ability to synchronize operations.

Finally, the "Engineer Restructure Initiative" expands the maneuver commander's overall ability to achieve *DEPTH*. By positioning organic engineers well forward, maneuver commanders are better able to maintain offensive momentum. However, the heavy division's lack of organic assets to cross dry gaps wider than 18.3 meters and all water obstacles may hinder the creation of battlefield *DEPTH*. At the same time, the problems associated with limited organic bridging assets are not insurmountable. With proper command emphasis and proactive planning, relying on

corps assets for specialized bridging missions should not be a serious problem.

In summary, the DIVENG regiment's organization, command and control, and tactical doctrine are sound. However, with the exception of the ACE, the regiment's equipment is generally inadequate for meeting the challenges of supporting maneuver units on the AirLand battlefield. The monograph's central question can now be answered, and final conclusions and recommendations offered.

CONCLUSIONS AND RECOMMENDATIONS

On the modern battlefield, engineer mobility operations are a key to unlocking the benefits of tactical freedom of action. Given this fact, is the DIVENG regiment capable of creating the conditions necessary to maintain the heavy division's tactical freedom of action? The answer to the monograph's central question is yes. By enhancing *INITIATIVE*, *AGILITY*, *SYNCHRONIZATION*, and *DEPTH*, the DIVENG regiment helps maintain the heavy division's overall tactical freedom of action. Further, the DIVENG regiment unquestionably represents an improved use of currently available engineer resources in support of the combined arms team.

From the study conducted, three major additional conclusions and recommendations emerge. First, the US Army must develop an in-stride obstacle breaching capability. Even under DIVENG, a great disparity exists between doctrinal requirements for attaining tactical freedom of action and the ability of sappers to achieve such requirements. Specifically, today's Army cannot breach and cross obstacles in-stride. Consequently, deliberate obstacle breaching operations will continue as the rule rather than the exception.

Second, the Army must modernize engineer

equipment. With the exception of the armored combat earthmover, most engineer equipment represents circa 1950s technology attempting to support, in essence, 21st century combat systems. The armored personnel carrier, combat engineer vehicle, armored vehicle launched bridge, and mine clearing line charge are ill suited to supporting maneuver units on a fluid, non-linear, fast paced battlefield. In the final analysis, inadequate sapper equipment is not an engineer problem; inadequate sapper equipment is a combined arms team problem.

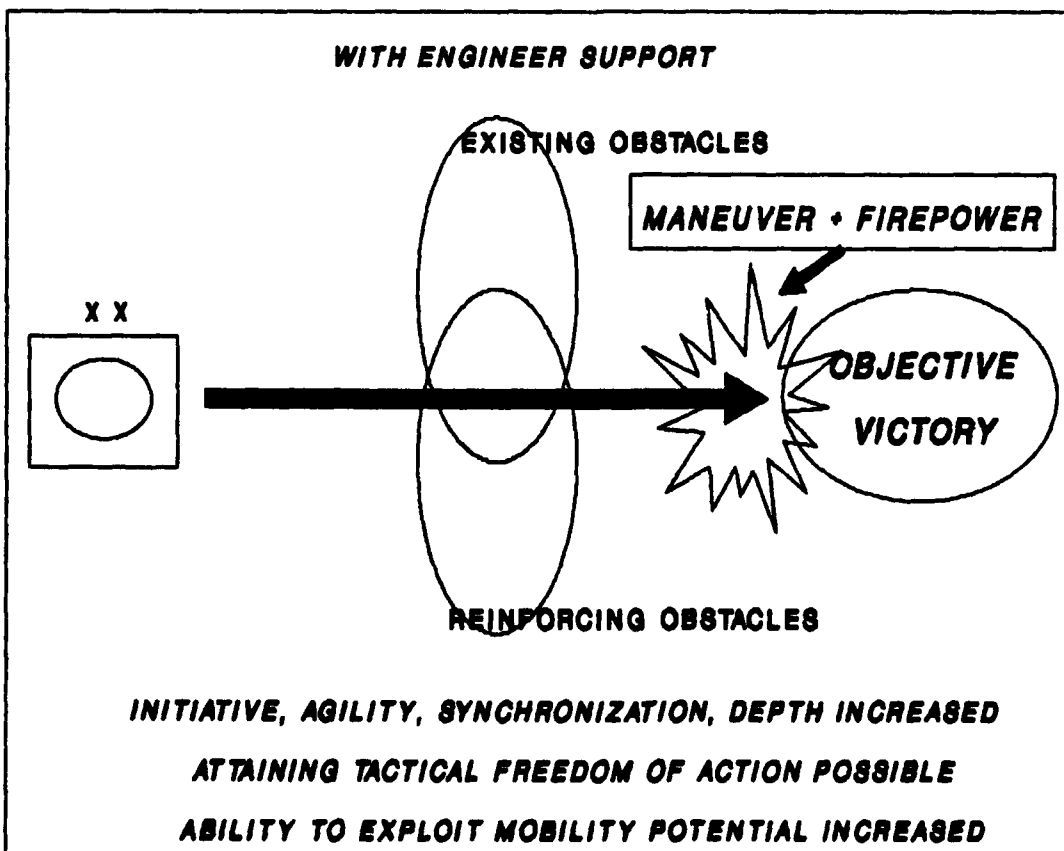
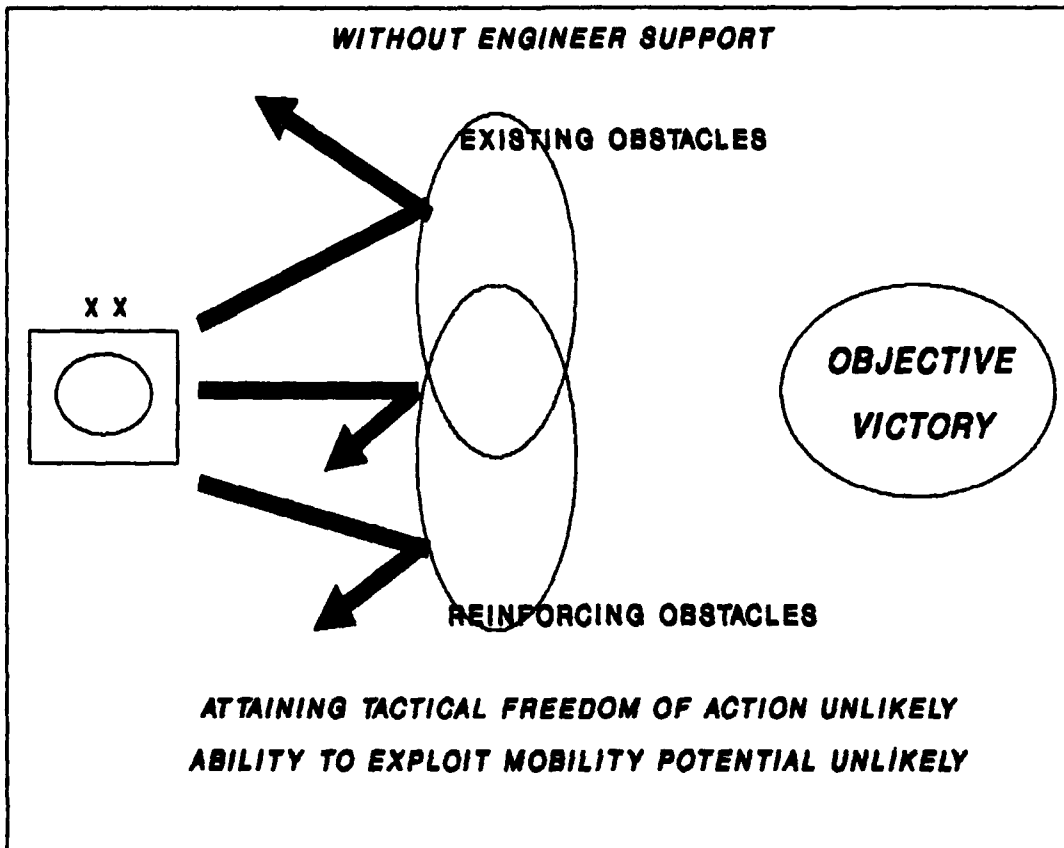
Finally, the obsolescence of most engineer equipment highlights the need to harmonize all of the Battlefield Operating Systems' components.⁹² General William DePuy--the first Training and Doctrine Command (TRADOC) commander--stated: "If we teach it [doctrine] and we believe it [doctrine], then we better buy the weapons that make it [doctrine] work."⁹³ General DePuy's words make sense. Unfortunately, the DIVENG regiment's equipment indicates an unwillingness to bring engineer equipment to a level of excellence commensurate with the Abrams Tank and the Bradley Fighting Vehicle. In an era of scarce fiscal resources, the prospect for the non-parochial perspective required to harmonize all parts of the

Battlefield Operating System are poor. Until such harmonization occurs, the full potential of AirLand Battle doctrine can never be reached.

Appendix 1 - Applicable Theory Reference Material

A. Relationships Between Mobility, Engineer Support in Offensive Operations, and Tactical Freedom of Action

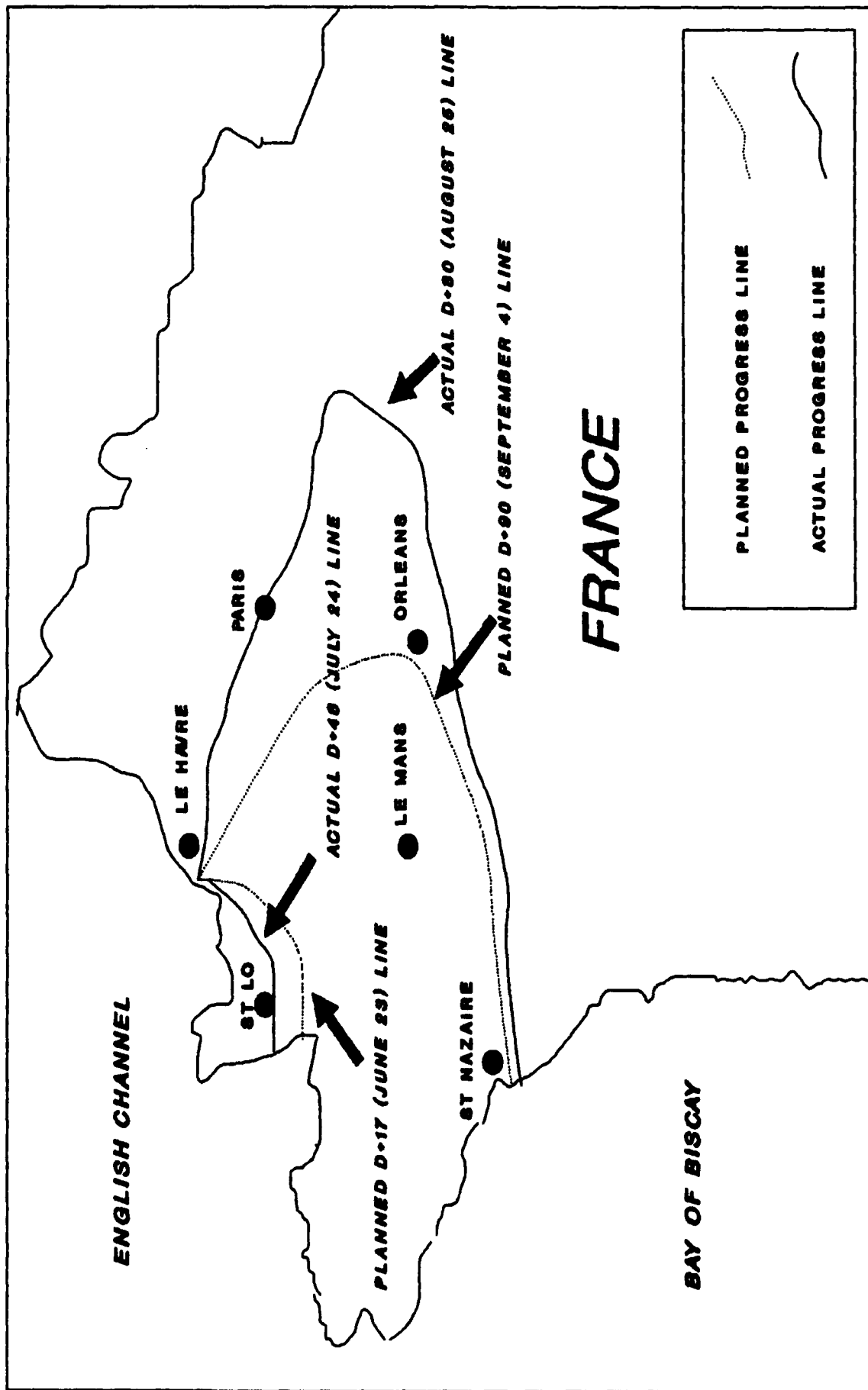
**APPENDIX 1-A: RELATIONSHIPS BETWEEN
MOBILITY, ENGINEER SUPPORT IN OFFENSIVE
OPERATIONS, AND TACTICAL FREEDOM OF ACTION**



Appendix 2 - Normandy Reference Maps

A. American pre- and post-COBRA Progress*

Appendix 2-A: American pre- and post-COBRA Progress



Appendix 3 - German Counteroffensive Reference Maps

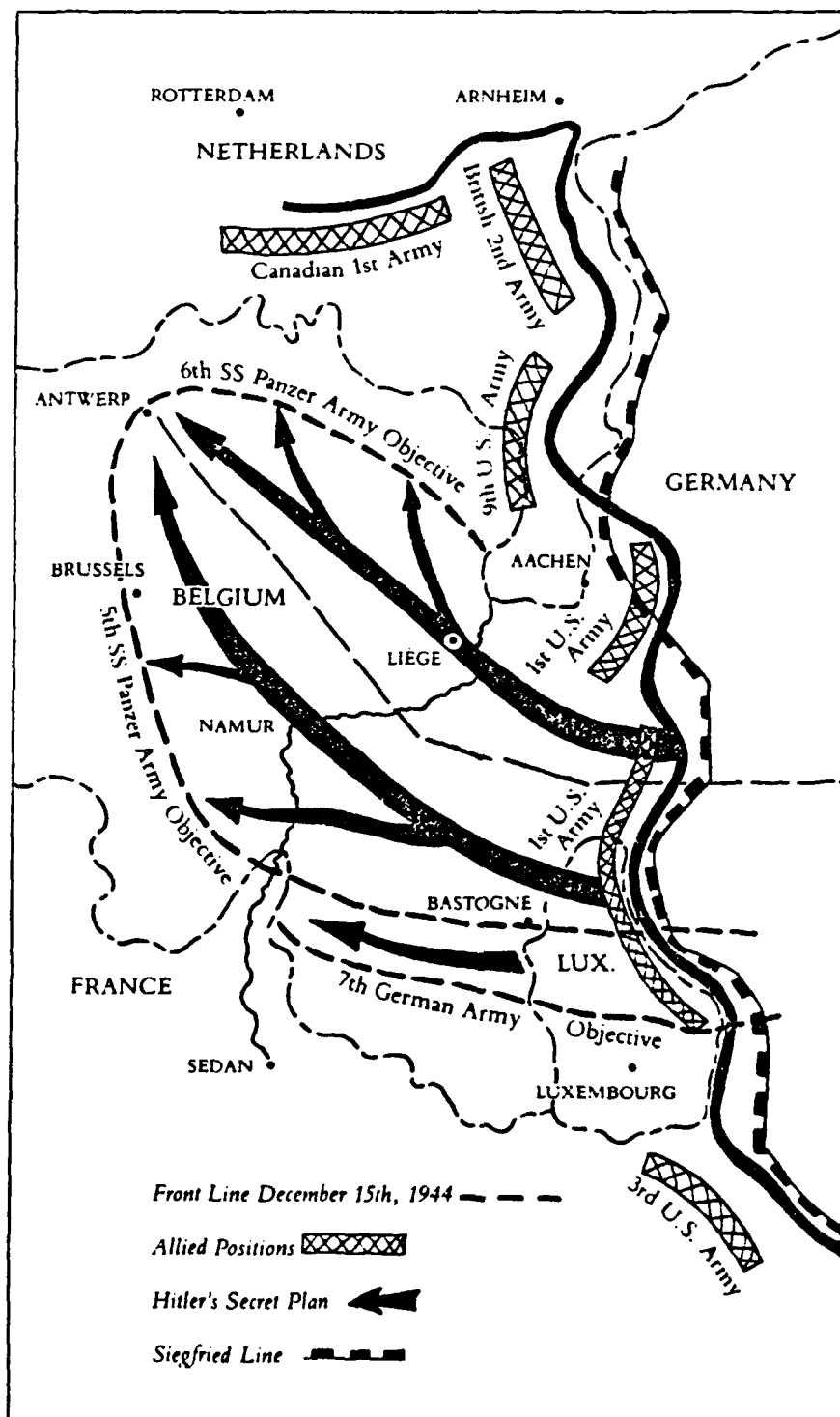
A. *WACHT AM RHEIN* Counteroffensive Overview⁹⁵

B. *Kampfgruppe Peiper* Timetable⁹⁶

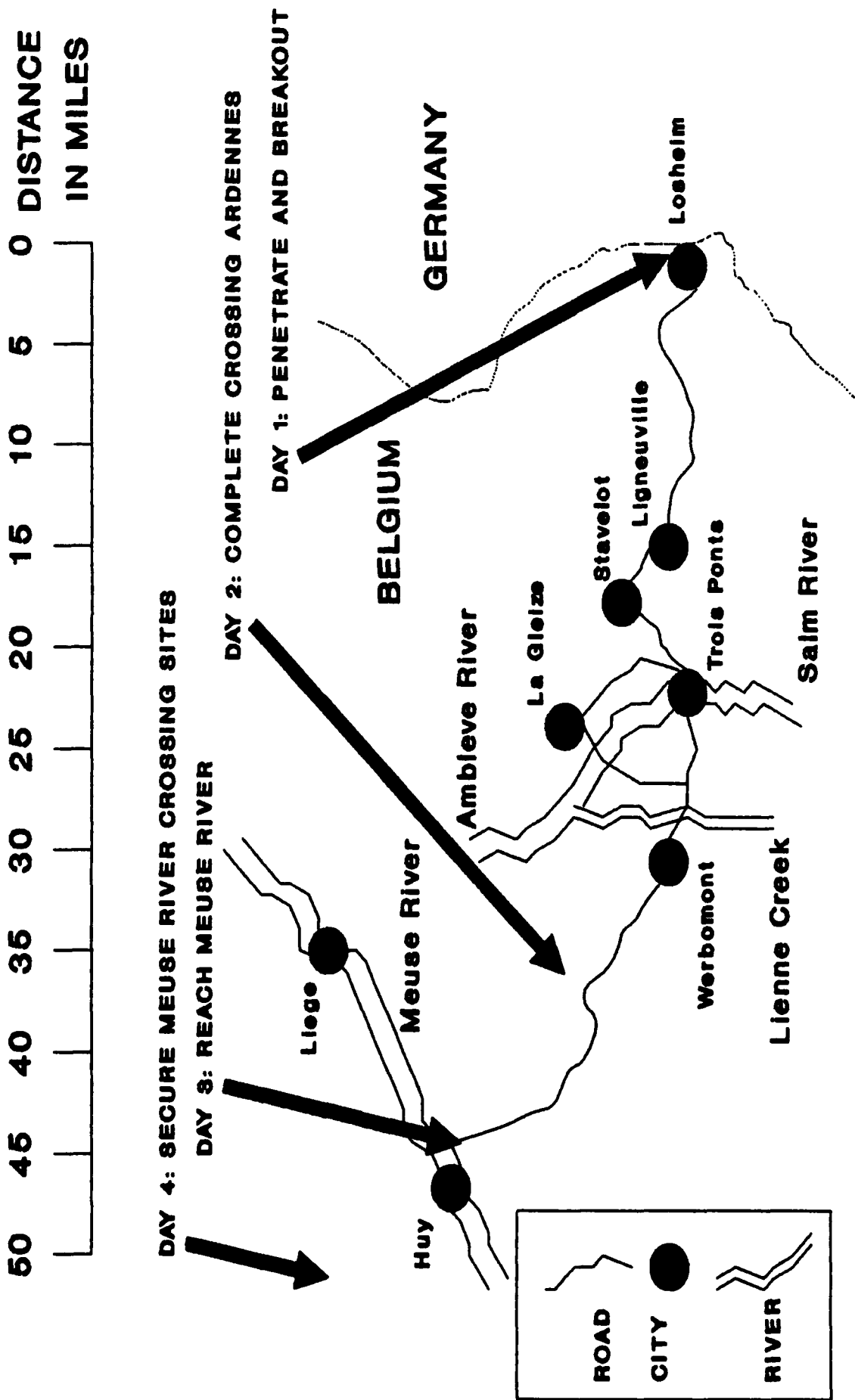
C. *Kampfgruppe Peiper* Area of Operations⁹⁷

D. *Kampfgruppe Peiper* Planned Versus Actual Progress⁹⁸

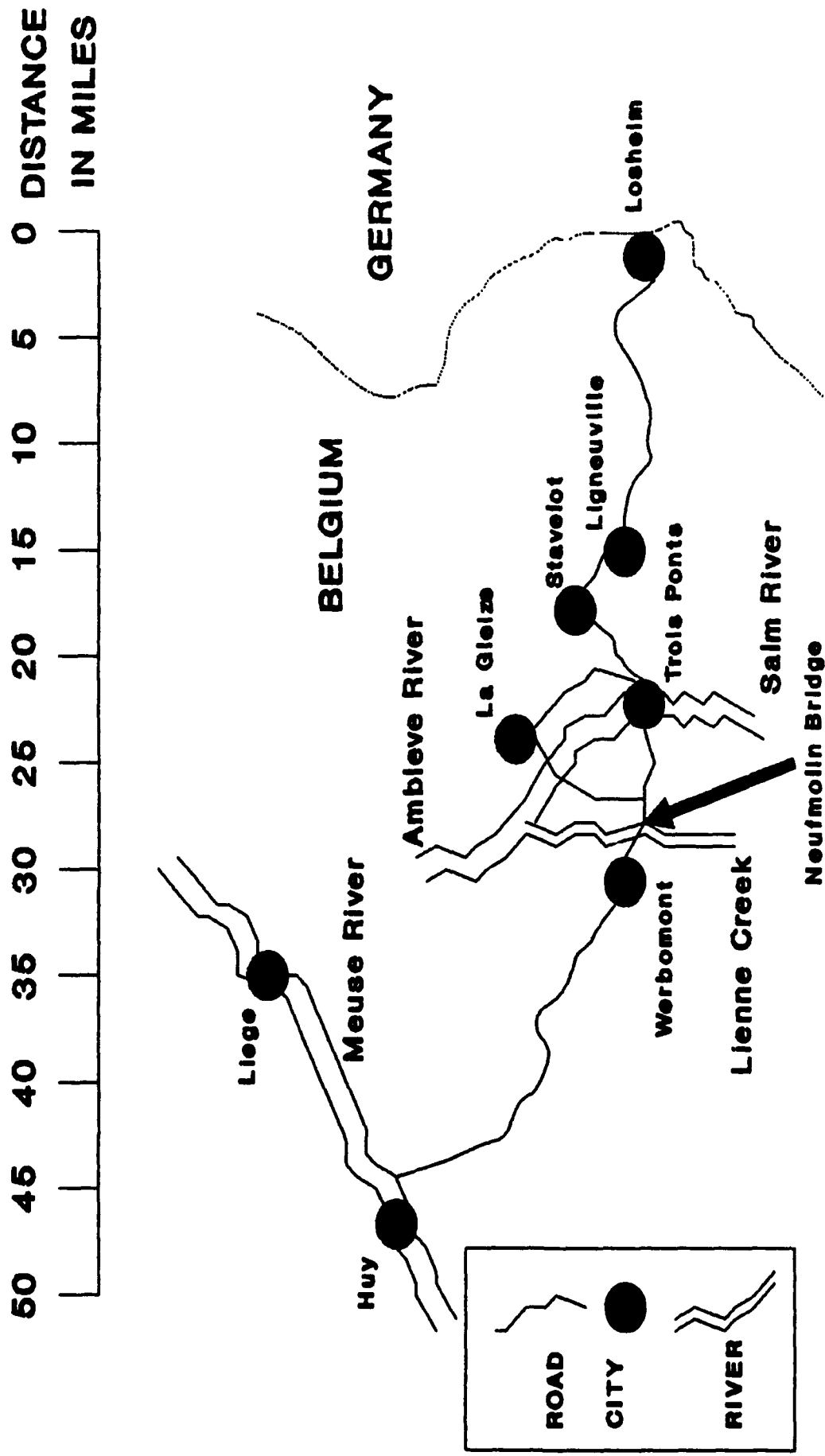
Appendix 3-A WACHT AM RHEIN COUNTEROFFENSIVE OVERVIEW



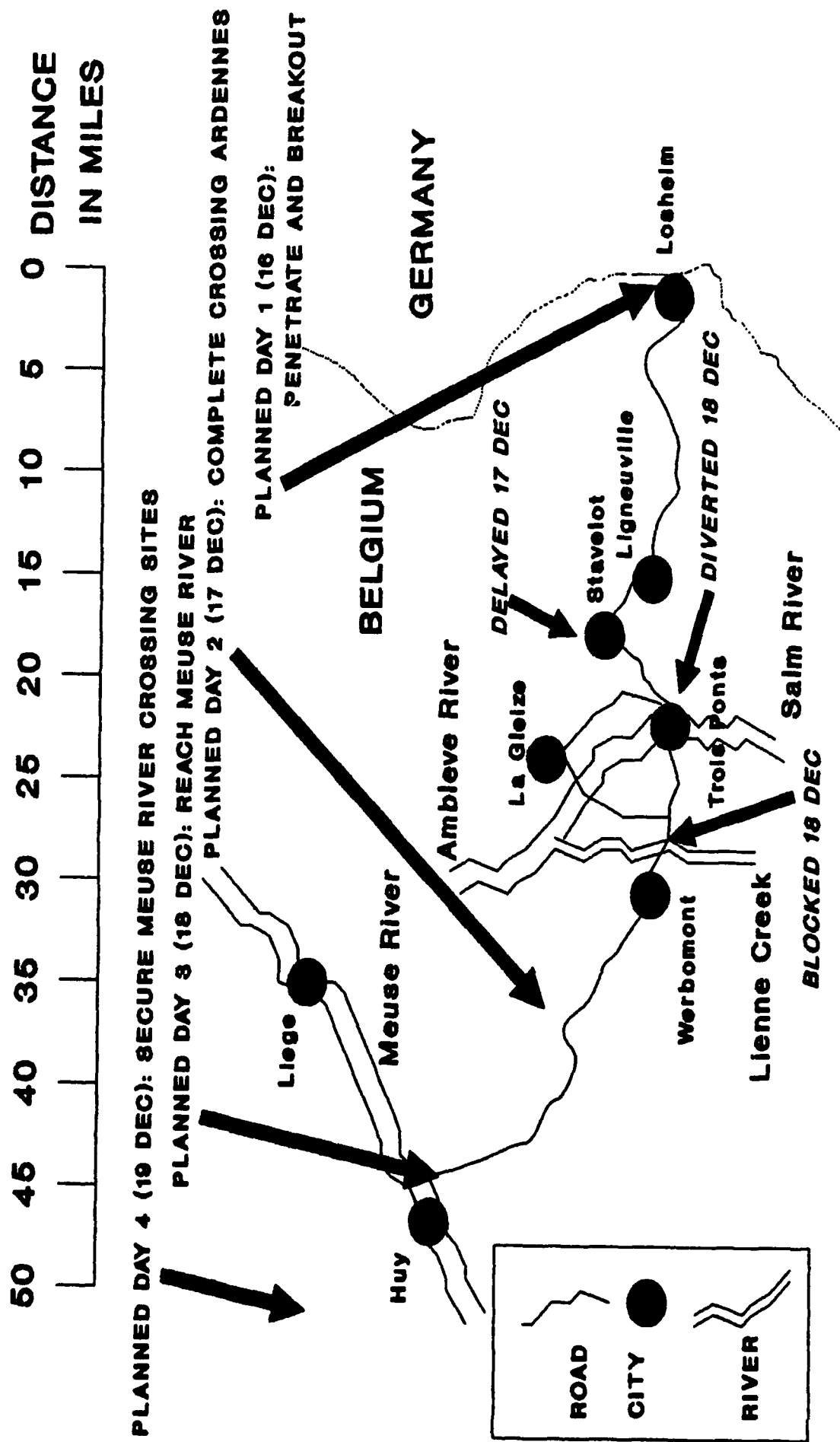
Appendix 3-B: KAMPFGRUPPE PEIPER TIMETABLE



Appendix 3-C: KAMPFGRUPPE PEIPER **AREA OF OPERATIONS**



Appendix 3-D: KAMPFGRUPPE PEIPER PLANNED VERSUS ACTUAL PROGRESS



Appendix 4 - DIVENG Regiment Reference Materials

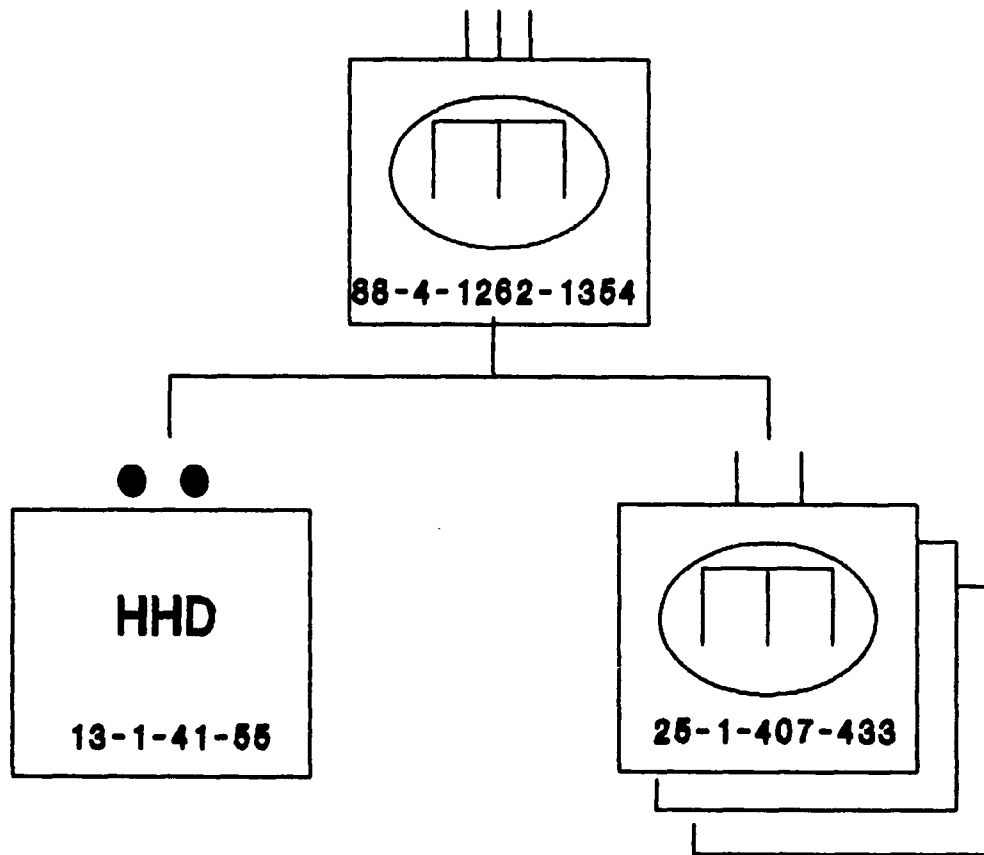
A. DIVENG Regiment Structure⁹⁹

B. DIVENG Sapper Battalion Structure¹⁰⁰

C. DIVENG Sapper Company Structure¹⁰¹

D. Equipment Comparison¹⁰²

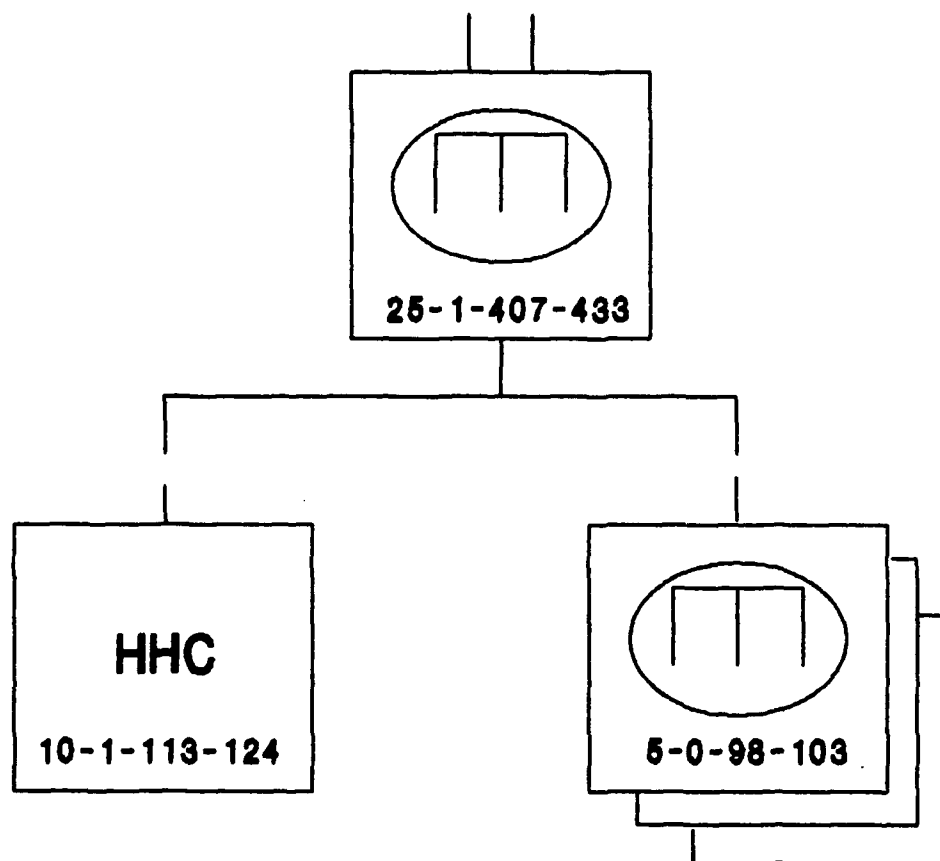
APPENDIX 4-A: DIVENG REGIMENT STRUCTURE



MAJOR ITEMS OF OFFENSIVE EQUIPMENT

ARMORED PERSONNEL CARRIERS	87
COMBAT ENGINEER VEHICLES	18
ARMORED VEHICLE LAUNCHED BRIDGES	36
MINE CLEARING LINE CHARGES	36
ARMORED COMBAT EARTHMOVERS	63

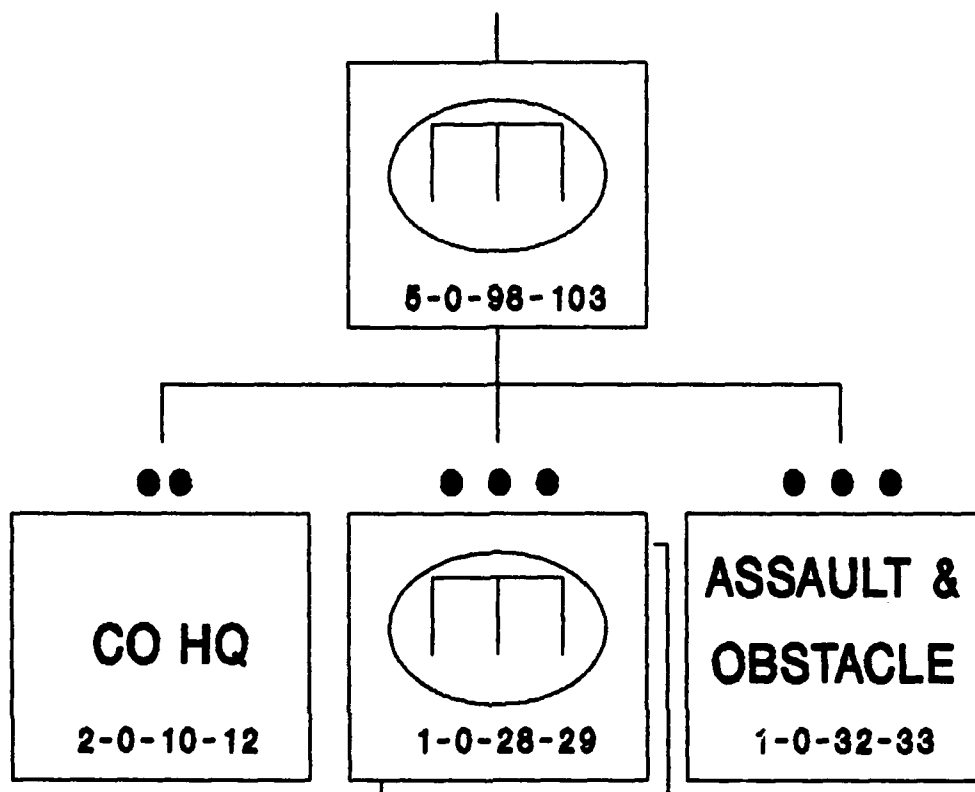
APPENDIX 4-B: DIVENG SAPPER BATTALION STRUCTURE



MAJOR ITEMS OF OFFENSIVE EQUIPMENT

ARMORED PERSONNEL CARRIERS	29
COMBAT ENGINEER VEHICLES	6
ARMORED VEHICLE LAUNCHED BRIDGES	12
MINE CLEARING LINE CHARGES	12
ARMORED COMBAT EARTHMOVERS	21

APPENDIX 4-C: DIVENG SAPPER COMPANY STRUCTURE



MAJOR ITEMS OF OFFENSIVE EQUIPMENT

ARMORED PERSONNEL CARRIERS	9
COMBAT ENGINEER VEHICLES	2
ARMORED VEHICLE LAUNCHED BRIDGES	4
MINE CLEARING LINE CHARGES	4
ARMORED COMBAT EARTHMOVERS	7

APPENDIX 4-D: EQUIPMENT COMPARISON

	CURRENT HEAVY	DIVENG HEAVY	PERCENT
	DIVISION	DIVISION	INCREASE
	ENGINEER BATTALION	REGIMENT	
ARMORED PERSONNEL CARRIERS	52	87	+ 67%
COMBAT ENGINEER VEHICLES	8	18	+125%
ARMORED VEHICLE LAUNCHED BRIDGES	24	36	+ 50%
MINE CLEARING LINE CHARGES	8	36	+350%
ARMORED COMBAT EARTHMOVERS	25	63	+150%

ENDNOTES

¹U.S. Department of the Army, *Technical Manual 9-2350-264-10-1, Tank, Combat, Full-Track 120-mm Gun, M1A1, General Abrams* (Washington, D.C.: U.S. Government Printing Office, 1985), p. 1-16; U.S. Department of the Army, *Technical Manual 9-2350-252-10-1, Fighting Vehicle, Infantry, M2/M2A1; Fighting Vehicle, Cavalry, M3/M3A1* (Washington, D.C.: U.S. Government Printing Office, 1986), p. 1-9.

²U.S. Department of the Army, *Field Manual 100-5, Operations* (Washington, D.C.: U.S. Government Printing Office, 1986), p. 131; *Field Manual 100-5*, p. 173.

³Carl E. Vouno, "The U.S. Army--Mobility and the Future of Deterrence," *NATO's Sixteen Nations*, vol. 35, no. 1 (February-March 1990), pp. 77 to 78.

⁴*Field Manual 100-5*, pp. 14 to 18.

⁵*Field Manual 100-5*, p. 131; *Field Manual 100-5*, p. 173.

⁶Sun Tzu, *The Art of War*, translated by Samuel B. Griffith (New York: Oxford University Press, 1963), p. 134.

⁷U.S. Army, *Field Manual 5-100, Engineer Combat Operations* (Washington, D.C.: U.S. Government Printing Office, 1988), p. 6; John M. Carmichael, *Maintaining Mobility on a High Tech Battlefield* (Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1989), p. 15.

⁸*Field Manual 100-5*, pp. 22 to 23.

⁹Vouno, pp. 77 to 78.

¹⁰Huba Wass de Czege, *Understanding and Developing Combat Power*, in Course Readings, AMSP Course 2 Tactical Dynamics Book 1 (Fort Leavenworth, Kansas: School of Advanced Military Studies, 1991), pp. 26 to 27.

¹¹Wass de Czege, p. 27; U.S. Army, *TRADOC Pam 11-9, Blueprint of the Battlefield* (Washington, D.C.: U.S. Government Printing Office, 1990), p. 25.

¹²U.S. Army, *Field Manual 5-101, Mobility* (Washington, D.C.: U.S. Government Printing Office, 1985), pp. 1-9 to 1-11.

¹³Peter Sheppard, "Mobility Support to Offensive Operations on the Modern Battlefield," *NATO's Sixteen Nations*, vol. 33, no. 7 (December 1988), pp. 66 to 67.

¹⁴Peter Boschmann, "River Crossing in the Central Region," *NATO's Sixteen Nations*, vol. 30, no. 3 (June-July 1985), p. 76.

¹⁵Hans-Henning von Sandrart, "Forward Defence--Mobility and the Use of Barriers," *NATO's Sixteen Nations*, vol. 30, no. 1 (Special Issue 1985), pp. 41+.

¹⁶Sheppard, p. 66.

¹⁷U.S. Army, *How to Breach a Scatterable Minefield* (Fort Leonard Wood, Missouri: ATSE-CA-T, U.S. Army Engineer School, 21 December 1990), p. 1.

¹⁸Sheppard, p. 66.

¹⁹*Field Manual 100-5*, p. 4.

²⁰A. Fastabend and Ralph H. Graves, "Maneuver, Synchronization and Obstacle Operations," *Military Review*, vol. 66, no. 2 (February 1986), p. 37.

²¹TRADOC Pam 11-9, p. 26.

²²Russell F. Weigley, "Shaping the American Army of World War II: Mobility versus Power," *Parameters*, vol. 11, no. 3 (September 1981), p. 19.

²³Russell F. Weigley, *Eisenhower's Lieutenants* (Bloomington, Indiana: Indiana University Press, 1981), p. 24.

²⁴Charles B. MacDonald, *The Mighty Endeavor* (New York: William Morrow, 1969), p. 321.

²⁵David E. Pergrin, *First Across the Rhine* (New York: Atheneum, 1989), p. 30; MacDonald, p. 321.

²⁶Pergrin, p. 31.; Weigley, *Eisenhower's Lieutenants*, pp. 14 to 15.

²⁷Pergrin, p. 33.

²⁸Martin Blumenson, *U.S. Army in World War II: The European Theater of Operations--Breakout and Pursuit* (Washington, D.C.: Office of the Chief of Military History, U.S. Army, 1984), p. 178.

²⁹Blumenson, p. vii.

- 30 Pergrin, pp. 31 to 34.
- 31 Pergrin, p. 34.
- 32 Omar N. Bradley, *A Soldier's Story* (New York: Henry Holt and Company, 1951), p. 318.
- 33 Bradley, p. 330.
- 34 Pergrin, p. 47.
- 35 The information on pre- and post-COBRA American progress was synthesized from a comparison of Maps 53, 59, and 65 in the *Atlas for the Second World War: Europe and the Mediterranean (The West Point Military History Series)*, ed. Thomas E. Griess (Wayne, New Jersey: Avery Publishing Group, 1985).
- 36 Blumenson, p. 180.
- 37 Charles B. MacDonald, *A Time for Trumpets* (New York: Bantam Books, 1985), pp. 17 to 38.
- 38 Hugh M. Cole, *U.S. Army in World War II: The European Theater of Operations--The Ardennes: Battle of the Bulge* (Washington, D.C.: Office of the Chief of Military History, U.S. Army, 1965), p. 19.
- 39 Cole, p. 69; Cole, p. 75.
- 40 Cole, pp. 260 to 261.
- 41 Cole, p. 260.
- 42 Pergrin, pp. 141 to 142.
- 43 Cole, p. 264.
- 44 Cole, p. 77.
- 45 Pergrin, p. 137; Cole, p. 77.
- 46 MacDonald, *A Time for Trumpets*, pp. 160 to 183.
- 47 Cole, p. 264.
- 48 Pergrin, pp. 101 to 104.
- 49 Cole, p. 266.
- 50 Cole, p. 267.
- 51 Pergrin, pp. 125 to 126.

- ⁵²Cole, p. 268; Pergrin, pp. 126 to 127.
- ⁵³Cole, p. 268.
- ⁵⁴Pergrin, pp. 133 to 137.
- ⁵⁵Janice Holt Giles, *The Damned Engineers* (Boston: Houghton Mifflin Company, 1970), p. 267; Pergrin, p. 167; Cole, p. 268.
- ⁵⁶Cole, pp. 268 to 269; Pergrin, p. 166.
- ⁵⁷*Field Manual 100-5*, p. 14; *Field Manual 5-100*, p. 31.
- ⁵⁸*Field Manual 100-5*, p. 35.
- ⁵⁹*Field Manual 100-5*, p. 11.
- ⁶⁰*Field Manual 100-5*, p. 12.
- ⁶¹*Field Manual 100-5*, p. 12.
- ⁶²*Field Manual 100-5*, p. 41; *Field Manual 100-5*, p. 2.
- ⁶³*Field Manual 100-5*, p. 51; *Field Manual 5-100*, p. 9.
- ⁶⁴*Field Manual 100-5*, p. 50; *Field Manual 5-100*, p. 43.
- ⁶⁵U.S. Army, *Field Manual 5-71-100, Regimental Engineer Combat Operations (Coordinating Draft)*, (Washington, D.C.: U.S. Government Printing Office, 1991), p. iii; *Field Manual 5-71-100*, p. 4-1.
- ⁶⁶*Field Manual 5-71-100*, p. 2-19; *Field Manual 5-71-100*, p. 2-2.
- ⁶⁷*Field Manual 5-71-100*, p. 2-20.
- ⁶⁸*Field Manual 5-71-100*, p. 1-4.
- ⁶⁹*Field Manual 5-71-100*, p. 2-1; *Field Manual 5-71-100*, pp. 2-27 to 2-28.
- ⁷⁰*Field Manual 5-71-100*, pp. 2-1 to 2-2.
- ⁷¹*Field Manual 100-5*, p. 22.
- ⁷²*Field Manual 5-71-100*, p. 4-7.

73 *Field Manual 5-71-100*, p. A-2.

74 Lawrence M. Jackson II, "Force Modernization-- Doctrine, Organization, and Equipment." *Military Review*, vol. 62, no. 12 (December 1982), pp. 2 to 12.

75 Vernon Lowrey, "Initial Observations By Engineers in the Gulf War," *Engineer*, vol. 21 (October 1991), p. 47; *Combat Engineer Systems Handbook* (U.S. Army Engineer School, Fort Leonard Wood, Missouri, 1991), p. 21. [hereafter referred to as *Handbook*]

76 Lowrey, p. 46; *Handbook*, p. 8.

77 *Handbook*, p. 21.

78 Sheppard, p. 66.

79 *Handbook*, p. 3.

80 *Handbook*, p. 3.

81 *Handbook*, p. 24.

82 Lowrey, p. 47.

83 *Handbook*, p. 72.

84 Lowrey, p. 44.

85 "U.S. Army General Officer Steering Committee Countermine Master Plan--A Strategy for Countermine Preparedness." (Fort Leonard Wood, Missouri: U.S. Army Engineer School Directorate of Combat Developments, September 1988), p. ES-5. [hereafter referred to as "Countermine Master Plan"]

86 *Handbook*, p. 17.

87 James W. Delony. *Tactical Mobility and the In-Stride Obstacle Breach: Impossible, Probable, or Futuristic?* (Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1988), p. 41; Sheppard, p. 67; Kerry K. Pierce. *E-Force: How Agile Is It?* (Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1986), p. 31; Joseph Schroedel. *Tactical Mobility: Organizing Engineers for an All Arms Problem* (Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1987), p. 31.

88 "Countermine Master Plan," p. 3-2.

89Gordon M. Wells. *U.S. Army River Crossing Doctrine and AirLand Battle Future: Applicable or Anachronistic?* (Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1990), pp. 31 to 41.

90*Field Manual 100-5*, p. 15.

91"Combined Arms Breaching Operations," *1991 CGSOC Engineer Update* (Fort Leonard Wood, Missouri: U.S. Army Engineer School, 1991), p. 1.

92The idea of a need for harmony between different components of a system was stimulated by James M. Dubik, *Grant's Final Campaign: A Study of Operational Art* (Fort Leavenworth, Kansas: School of Advanced Military Studies, 1991), pp. 30 to 34, and James M. Dubik, *A Guide to the Study of Operational Art and Campaign Design* (Fort Leavenworth, Kansas: School of Advanced Military Studies, 1991), pp. 8 to 9.

93Paul H Herbert. *Deciding What Has to be Done: General William E. DePuy and the 1976 Edition of FM 100-5, Operations; Leavenworth Papers, Number 16* (Fort Leavenworth, Kansas: Combat Studies Institute, 1988), p. 102.

94The information on pre- and post-COBRA American progress was synthesized from a comparison of Maps 53, 59, and 65 in the *Atlas for the Second World War: Europe and the Mediterranean (The West Point Military History Series)*, ed. Thomas E. Griess (Wayne, New Jersey: Avery Publishing Group, 1985), Maps 53, 59, and 65.

95Pergrin, map p. 80.

96*Kampfgruppe Peiper* timetable from Cole, p. 77; Map topographic features synthesized from: MacDonald, *A Time for Trumpets*, map p. 162; Cole, *Map II*; Pergrin, map p. 96.

97Map topographic features synthesized from: MacDonald, *A Time for Trumpets*, map p. 162; Cole, *Map II*; Pergrin, map p. 96; Pergrin, map p. 130.

98 *Kampfgruppe Peiper* timetable from Cole, p. 77; *Kampfgruppe Peiper* actual progress from monograph narrative; Map topographic features synthesized from: MacDonald, *A Time for Trumpets*, map p. 162; Cole, *Map II*; Pergrin, map p. 96; Pergrin, map p. 130.

99 *Field Manual 5-71-100*, pp. A-2 to A-3.

100 *Field Manual 5-71-100*, p. A-5.

101 *Field Manual 5-71-100*, p. A-9.

102 "Engineer Organizations--Engineer Battalion Heavy Division," *1991 CGSOC Engineer Update* (Fort Leonard Wood, Missouri: U.S. Army Engineer School, 1991), pp. 9 to 10; *Field Manual 5-71-100*, p. A-2.

BIBLIOGRAPHY

Books

- Bellamy, Chris. *The Future of Land Warfare*. New York: St. Martin's Press, 1987.
- Bellamy, Christopher. *The Evolution of Modern Land Warfare*. London: Routledge, 1990.
- Blumenson, Martin. *U.S. Army in World War II: The European Theater of Operations--Breakout and Pursuit*. Washington, D.C.: Office of the Chief of Military History, US Army, 1984.
- Bradley, Omar N. *A Soldier's Story*. New York: Henry Holt and Company, 1951.
- Clausewitz, Carl von. *On War*. Edited and translated by Michael Howard and Peter Paret. Princeton, NJ: Princeton University Press, 1984.
- Cole, Hugh M. *U.S. Army in World War II: The European Theater of Operations--The Ardennes: Battle of the Bulge*. Washington, D.C.: Office of the Chief of Military History, US Army, 1965.
- Donnelly, Christopher. *Red Banner*. Alexandria, VA: Jane's Publishing, 1988.
- Giles, Janice Holt. *The Damned Engineers*. Boston: Houghton Mifflin Company, 1970.
- Griess, Thomas E., editor. *Atlas for the Second World War: Europe and the Mediterranean (The West Point Military History Series)*. Wayne, New Jersey: Avery Publishing Group, 1985.
- Jomini, Antoine Henri. *The Art of War*. Translated by BG J. D. Hittle in *The Roots of Strategy*, Book II, pp. 388-557. Harrisburg, Pennsylvania: Stackpole Books, 1987.
- Keegan, John. *The Face of Battle*. New York: Penguin Books, 1976.
- Marshall, S.L.A. *Men Against Fire*. Gloucester, Massachusetts: Peter Smith, 1978.
- MacDonald, Charles B. *A Time for Trumpets*. New York: Bantam Books, 1985.

- MacDonald, Charles B. *The Mighty Endeavor*. New York: William Morrow, 1969.
- Pergrin, David E. *First Across the Rhine*. New York: Atheneum, 1989.
- Rostow, W. W. *The Stages of Economic Growth*. Cambridge, England: Cambridge University Press, 1960.
- Simpkin, Richard E. *Race to the Swift*. London: Brassey's Defence Publishers, 1985.
- Slim, William. *Defeat Into Victory*. London: Cassell & Co., 1956.
- Sun Tzu. *The Art of War*. Translated by Samuel B. Griffith. New York: Oxford University Press, 1963.
- Sydnor, Charles W. Jr. *Soldiers of Destruction*. Princeton, New Jersey: Princeton University Press, 1977.
- The G.I. Journal of Sergeant Giles*. Compiled and edited by Janice Holt Giles. Boston: Houghton Mifflin Company, 1965.
- van Creveld, Martin. *Command in War*. Cambridge, Massachusetts: Harvard University Press, 1988.
- Weigley, Russell F. *Eisenhower's Lieutenants*. Bloomington, Indiana: Indiana University Press, 1981.

Periodicals and Articles

- Bornhoft, Stewart H. "Force Multiplier--Useless Cliche or Useful Concept?" *Military Review*, vol. 63, no. 1 (January 1983), pp. 2 to 8.
- Boschmann, Peter. "River Crossing in the Central Region." *NATO's Sixteen Nations*, vol. 30, no. 3 (June-July 1985), pp. 76 to 78+.
- Draper, Stephen E. "Mobility/Counter-mobility in Winter Warfare." *Defence Update International*, vol. 45 (1984), pp. 55 to 63.
- Eshel, David. "Tracks or Wheels?" *Defence Update International*, vol. 48 (1984), pp. 4 to 12.
- "Expendable Drones--Can They Restore Battlefield Mobility?" *Defence Update International*, vol. 90 (August 1988), pp. 25 to 31+.

- Fastabend, A. and Ralph H. Graves. "Maneuver, Synchronization and Obstacle Operations." *Military Review*, vol. 66, no. 2 (February 1986), pp. 36 to 48.
- Gabel, Christopher R. "Evolution of US Armor Mobility." *Military Review*, vol. 64, no. 3 (March 1984), pp. 54 to 63.
- Gillois, Jean. "Mobility on the Battlefield." *NATO's Fifteen Nations*, vol. 26, no. 1 (Special Issue 1981), pp. 96 to 103.
- Heslin, John G. "Mobility: Key to Success on the Extended Battlefield." *Military Review*, vol. 61, no. 8 (August 1981), pp. 57 to 63.
- Jackson, Lawrence M., II. "Force Modernization-- Doctrine, Organization, and Equipment." *Military Review*, vol. 62, no. 12 (December 1982), pp. 2 to 12.
- Lowrey, Vernon. "Initial Observations By Engineers in the Gulf War." *Engineer*, vol. 21 (October 1991), pp. 42 to 48.
- Mountcastle, John W. "On the Move: Command and Control of Armor Units in Combat." *Military Review*, vol. 65, no. 11 (November 1985), pp. 14 to 39.
- Record, Jeffrey. "Getting There." *Parameters*, vol. 18, no. 2 (June 1988), pp. 89 to 95.
- Schneider, James J. "The Theory of the Empty Battlefield." In *RUSI Journal of the Royal United Services Institute for Defence Studies*, (Summer 1987), pp. 37 to 44.
- Sheppard, Peter. "Mobility Support to Offensive Operations on the Modern Battlefield." *NATO's Sixteen Nations*, vol. 33, no. 7 (December 1988), pp. 65 to 68+.
- "The German Army's Mission-Oriented Command and Control." *Armor*, vol. 40, no. 1 (January-February 1981), pp. 12 to 16.
- von Sandrart, Hans-Henning. "Forward Defence--Mobility and the Use of Barriers." *NATO's Sixteen Nations*, vol. 30, no. 1 (Special Issue 1985), pp. 37+.
- Vouno, Carl E. "The U.S. Army--Mobility and the Future of Deterrence." *NATO's Sixteen Nations*, vol. 35, no. 1 (February-March 1990), pp. 75 to 78+.

Weigley, Russell F. "Shaping the American Army of World War II: Mobility versus Power." *Parameters*, vol. 11, no. 3 (September 1981), pp. 13 to 21.

Wilson, John B. "Mobility versus Firepower: The post-World War I Infantry Division." *Parameters*, vol. 13, no. 3 (September 1983), pp. 47 to 52.

Wright, Thomas. "Mobile Obstacles for a Mobile Defence." *NATO's Sixteen Nations*, vol. 34, no. 7 (December 1989), pp. 52 to 55.

Government Documents, Manuals and Lectures

Arnold, Edwin J., Jr. *American River Crossing Doctrine: A Look at Its Compatibility With Current Force Structure and the Modern Battlefield*. Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1985.

Benjamin, David J. *An AirLand Battle Challenge: To Cross A River*. Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1985.

Carmichael, John M. *Maintaining Mobility on a High Tech Battlefield*. Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1989.

Combat Engineer Systems Handbook. U.S. Army Engineer School, Fort Leonard Wood, Missouri, 1991.

Cottrell, Scott D. *Command and Control Relationships and Organization of Engineer Support to the Heavy Division*. Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1985.

Cottrell, Scott D. *From Cobra to the Seine, August 1944: A Microcosm of the Operational Art*. Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1986.

Cranz, Donald. *Understanding Change: Sigismund von Schlichting and the Operational Level of War*. Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1989.

Delony, James W. *Tactical Mobility and the In-Stride Obstacle Breach: Impossible, Probable, or Futuristic?* Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1988.

- Dubik, James M. *A Guide to the Study of Operational Art and Campaign Design*. Fort Leavenworth, Kansas: School of Advanced Military Studies, 1991.
- Dubik, James M. *Grant's Final Campaign: A Study of Operational Art*. Fort Leavenworth, Kansas: School of Advanced Military Studies, 1991.
- Herbert, Paul H. *Deciding What Has to be Done: General William E. DePuy and the 1976 Edition of FM 100-5, Operations*. Leavenworth Papers, Number 16. Fort Leavenworth, Kansas: Combat Studies Institute, 1988.
- Pierce, Kerry K. *E-Force: How Agile Is It?* Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1986.
- Schneider, James J. *Theoretical Paper Number 3*. Fort Leavenworth, Kansas: School of Advanced Military Studies, 1988.
- Schneider, James J. *VULCAN'S ANVIL: The American Civil War and the Emergence of Operational Art*. Theoretical Paper No. 4. Fort Leavenworth, Kansas: School of Advanced Military Studies, 1991.
- Schroedel, Joseph. *Tactical Mobility: Organizing Engineers for an All Arms Problem*. Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1987.
- United States Army. "Combined Arms Breaching Operations," *1991 CGSOC Engineer Update*. Fort Leonard Wood, Missouri: US Army Engineer School, 1991.
- _____. "Engineer Organizations," *1991 CGSOC Engineer Update*. Fort Leonard Wood, Missouri: US Army Engineer School, 1991.
- _____. *How to Breach a Scatterable Minefield*, prepared by Roger J. Somerville. Fort Leonard Wood, Missouri: ATSE-CA-T, US Army Engineer School, 21 December 1990.
- _____. *Field Manual 5-34, Engineer Field Data*. Washington, D.C.: US Government Printing Office, 1986.
- _____. *Field Manual 5-71-100, Regimental Engineer Combat Operations (Coordinating Draft)*. Washington, D.C.: US Government Printing Office, 1991.

- _____. *Field Manual 5-100, Engineer Combat Operations.* Washington, D.C.: US Government Printing Office, 1988.
- _____. *Field Manual 5-101, Mobility.* Washington, D.C.: US Government Printing Office, 1985.
- _____. *Field Manual 71-2, The Tank and Mechanized Infantry Battalion Task Force.* Washington, D.C.: US Government Printing Office, 1988.
- _____. *Field Manual 71-100, Division Operations.* Washington, D.C.: US Government Printing Office, 1990.
- _____. *Field Manual 90-13, River Crossing Operations.* Washington, D.C.: US Government Printing Office, 1990.
- _____. *Field Manual 100-5, Operations.* Washington, D.C.: US Government Printing Office, 1986.
- _____. *Field Manual 100-15, Corps Operations.* Washington, D.C.: US Government Printing Office, 1989.
- _____. "National Training Center Engineer Lessons Learned," *1991 CGSOC Engineer Update.* Fort Leonard Wood, Missouri: US Army Engineer School, 1991.
- _____. *Technical Manual 5-2350-262-10, Armored Combat Earthmover (ACE), M9.* Washington, D.C.: US Government Printing Office, 1990.
- _____. *Technical Manual 9-2350-252-10-1, Fighting Vehicle, Infantry, M2/M2A1; Fighting Vehicle, Cavalry, M3/M3A1.* Washington, D.C.: US Government Printing Office, 1986.
- _____. *Technical Manual 9-2350-264-10-1, Tank, Combat, Full-Track 120-mm Gun, M1A1, General Abrams.* Washington, D.C.: US Government Printing Office, 1985.
- _____. *TRADOC Pam 11-9, Blueprint of the Battlefield.* Washington, D.C.: U.S. Government Printing Office, 1990.
- _____. *TRADOC Pam 525-5B, AirLand Operations (Final Draft).* Washington, D.C.: U.S. Government Printing Office, 1991.

_____. "U.S. Army General Officer Steering Committee Countermine Master Plan--A Strategy for Countermine Preparedness." Fort Leonard Wood, Missouri: U.S. Army Engineer School Directorate of Combat Developments, 14 September 1988.

Wass de Czege, Huba. *Understanding and Developing Combat Power*. Course Readings, AMSP Course 2 Tactical Dynamics Book 1, Fort Leavenworth, Kansas: School of Advanced Military Studies, 1991.

Wells, Gordon M. *U.S. Army River Crossing Doctrine and AirLand Battle Future: Applicable or Anachronistic?* Fort Leavenworth, Kansas: School of Advanced Military Studies Monograph, 1990.